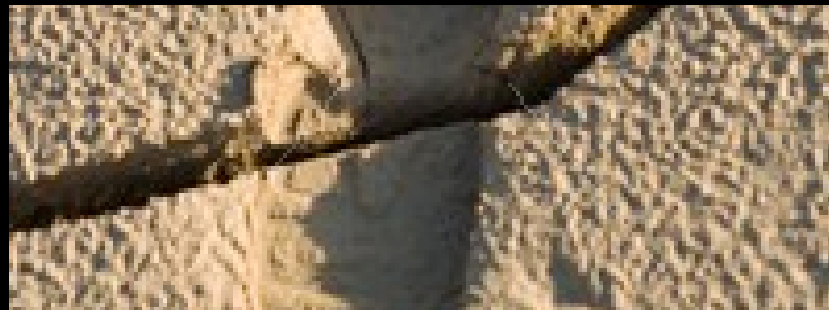


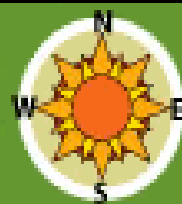
Climate Adaptation Planning



Science, Governance and Community Resilience



David Schaller, Administrator



City of Tucson Office of
**CONSERVATION AND
SUSTAINABLE DEVELOPMENT**

Six Major Greenhouse Gases

Carbon Dioxide (CO₂) (fossil fuel combustion, forest clearing, cement production, biomass decomposition)

Methane (CH₄) (landfills, rice cultivation, oil/gas production/combustion, livestock digestion fermentation)

Nitrous Oxide (N₂O) (fossil fuel combustion, nylon production, fertilizers, manure)

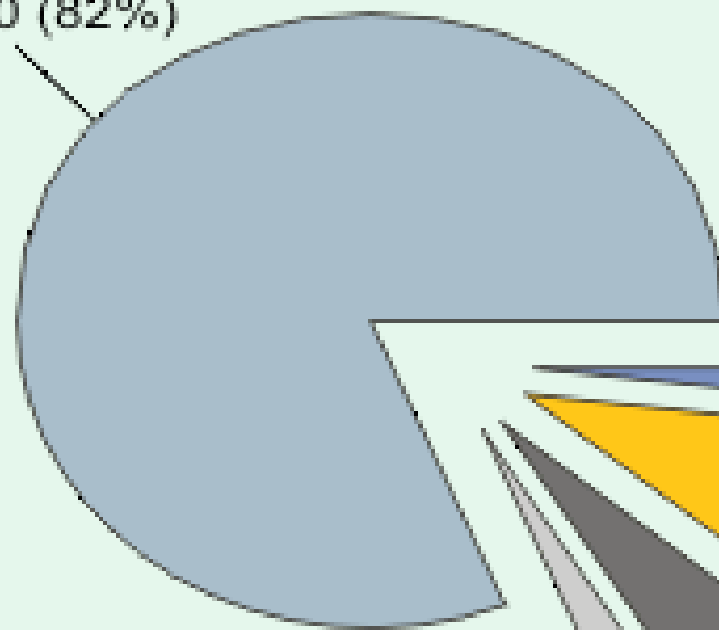
Six Major Greenhouse Gases

Hydrofluorocarbons (HFCs) (refrigeration gases, aluminum smelting, semiconductor mfg.)

Perfluorocarbons (PFCs) (aluminum production, semiconductor manufacturing)

Sulfur Hexafluoride (SF₆) (electric transmission/
distribution systems, circuit breakers,
magnesium production)

Carbon Dioxide from
Fossil Fuel Combustion
1,547.0 (82%)



Other Carbon Dioxide
31.7 (2%)

Methane
175.8 (9%)

Nitrous Oxide
97.5 (5%)

HFCs, PFCs, and SF₆
31.4 (2%)

Source: Energy Information Administration, Emissions of Greenhouse Gases
in the United States 2001 (Washington, DC, 2002)

Carbon Dioxide Equivalents (CO₂e)

- CO₂ - 1
- CH₄ - 23 to 25x more potent than CO₂
- N₂O - 296x
- PFCs - 5,700 to 11,900x
- HFCs - 12,000x
- SF₆ - 22,200x

Atmospheric CO₂

For at least a million years, global concentrations of CO₂ have never risen above 300 ppm.

Since the beginning of the industrial revolution global CO₂ levels have risen from 280 ppm to over 383 ppm in 2008.

In effect, there is 30% more CO₂ in the atmosphere today than there should be.

Atmospheric CH₄

For at least 650,000 years, global concentrations of CH₄ remained between 320–790 ppb.

Since the beginning of the industrial revolution global CH₄ levels have risen from 715 ppb to over 1774 ppb in 2005.

In effect, there is 150% more CH₄ in the atmosphere today than there should be.

What Goes Up Must Come Down, Right?

- By 2005, 8 billion metric tons of carbon were being emitted each year.
- 30% is absorbed by the oceans
- 30% is taken up by terrestrial ecosystems
- And 40% remains in the atmosphere
 - CO₂ for 500 years
 - CH₄ for 10 years
 - CFCs for tens of thousands of years
 - H₂O vapor, by comparison, for several days

HIGH

**System
Com-
plexity**

LOW

WICKED

WICKED MESSY

TAME

MESSY

LOW

Social Complexity

HIGH

CLIMATE CHANGE: The Limits of Our Thinking

- **Highly technical and complex**
- **Beyond anyone's experience or imagination**
- **Terrifying to contemplate**
- **Resistance to necessary changes**
- **Misinformation actively disseminated**

The Great Debate:

Mitigation vs. Adaptation

Against Adaptation


- Adaptation means giving up
- Adaptation takes resources from mitigation
- Adaptation is an industry preference
- Adaptation avoids changing business-as-usual

For Adaptation

- It is not an either-or choice we face,
we can and must do both
- Adaptation is good governance
- Adaptation is reality
- Adaptation (and Mitigation) is a case of
“Pay me now, or REALLY pay me later”

Mitigation or Adaptation

YES!



Adaptation: the ability of society to accommodate changes in climate with minimal potential social damage or economic cost

Behavioral changes

Technological solutions

Institutional adjustments

Climate Change Adaptation

- The rise in greenhouse gases is unlikely to slow or reverse in the near term
- Additional Climate Change is already in the pipeline
- Climate Change will continue long after greenhouse gases are stabilized

Climate Change Adaptation

- Adaptation reduces the impact of
climate stresses on human and
natural systems

We can anticipate



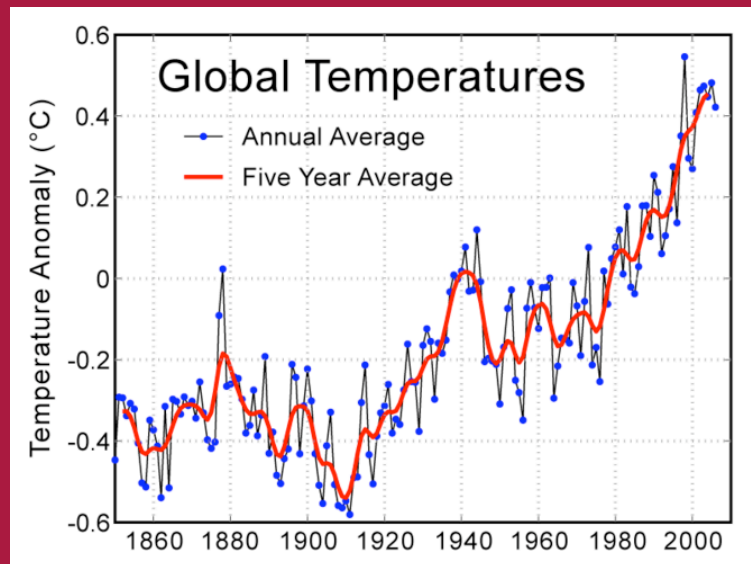
Or we can react



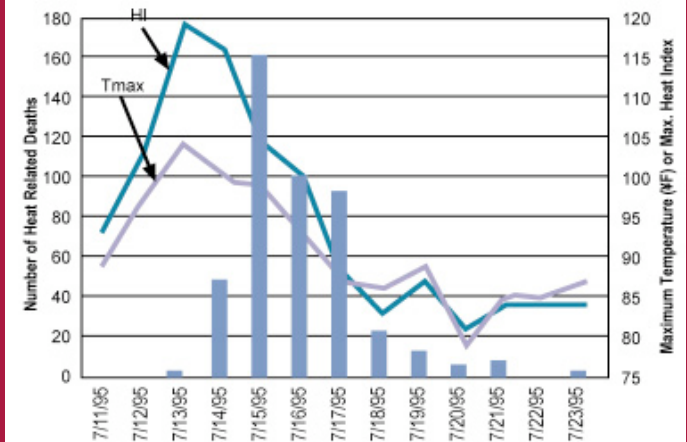
Direct and Indirect Impacts of Climate Change

- Direct Impacts: sea level rise in coastal areas; heat-related health issues in areas with rising temperatures
- Indirect Impacts: Loss of agricultural productivity affects distant communities; population movements from climate-impacted areas

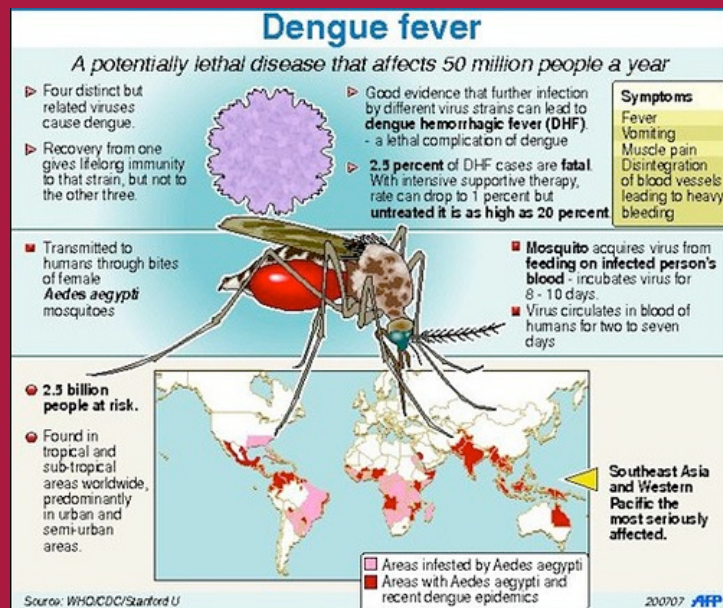
Direct Impacts



Heat Related Deaths - Chicago, July 1995
Maximum Temperature and Heat Index



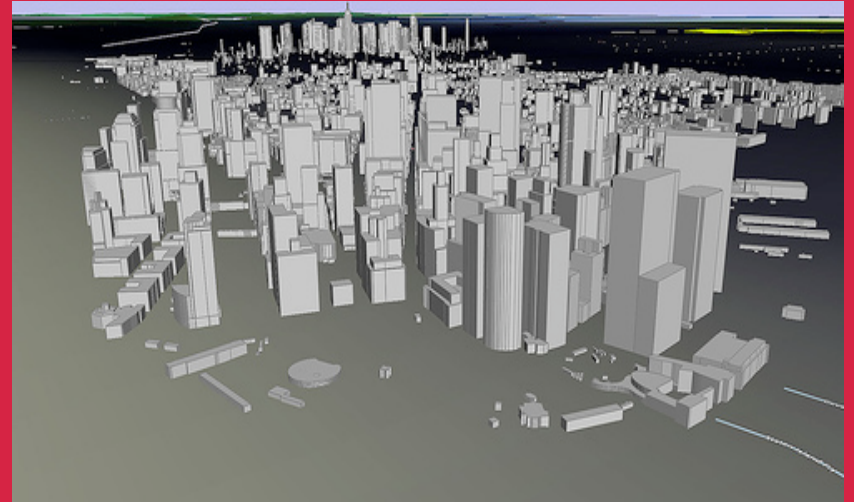
This graph tracks maximum temperature (Tmax), heat index (HI), and heat-related deaths in Chicago each day from July 11 to 23, 1995. The gray line shows maximum daily temperature, the blue line shows the heat index, and the bars indicate number of deaths for the day.



World's Most Dangerous Animals



Direct Impacts



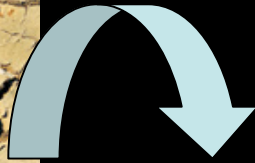
Sea Level Rise and Storm Surges





Infrastructure at Risk





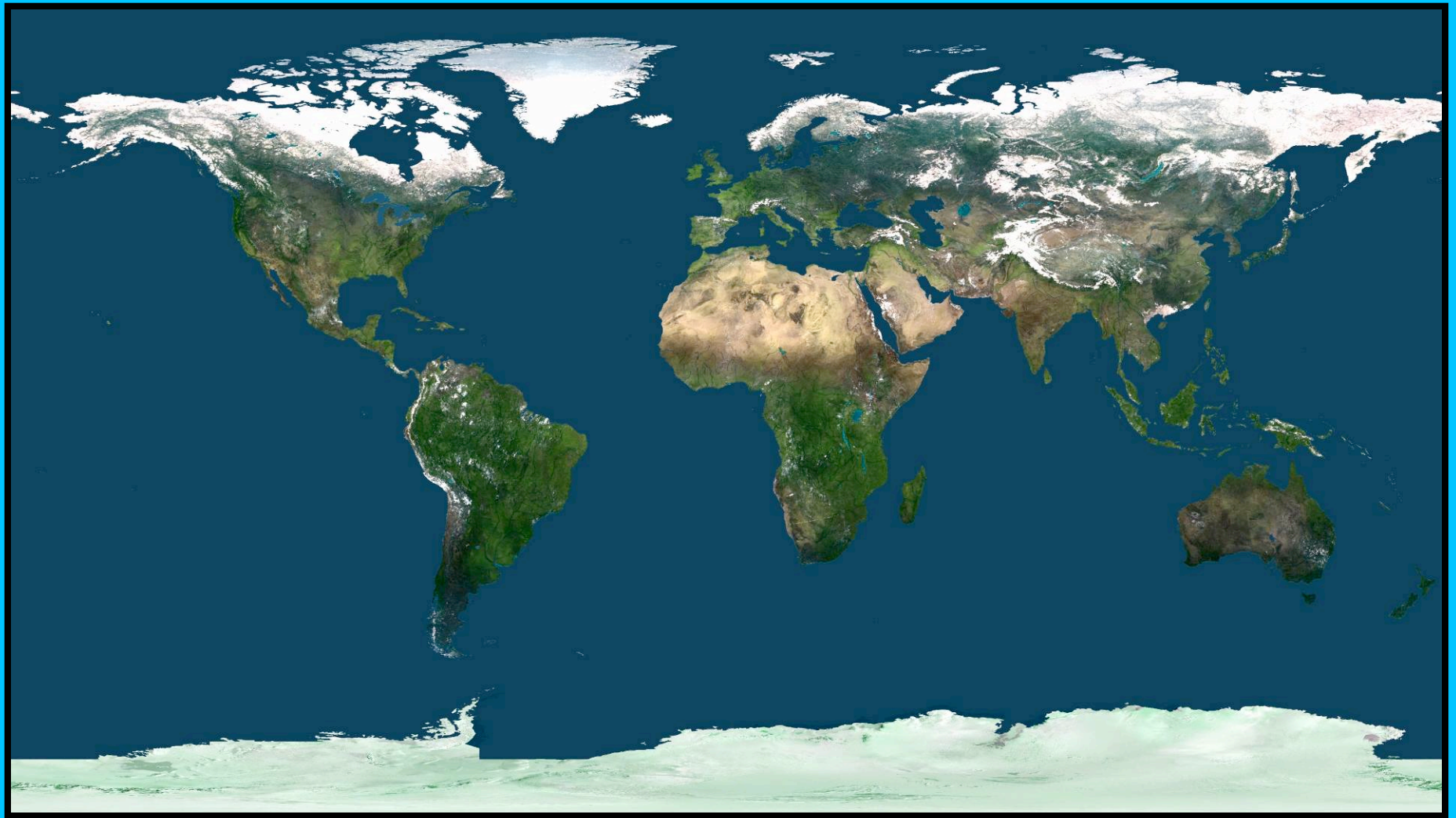
Indonesian workers sift rice at a warehouse in Jakarta, Indonesia, Monday, April 7, 2008. A global rice shortage that has seen prices of one of the world's most important staple foods increase by 50 per cent in the past two weeks alone is triggering an international crisis, with countries banning export and threatening serious punishment for hoarders. (AP Photo/Achmad Ibrahim)



Indirect Impacts - Agriculture and Food Security



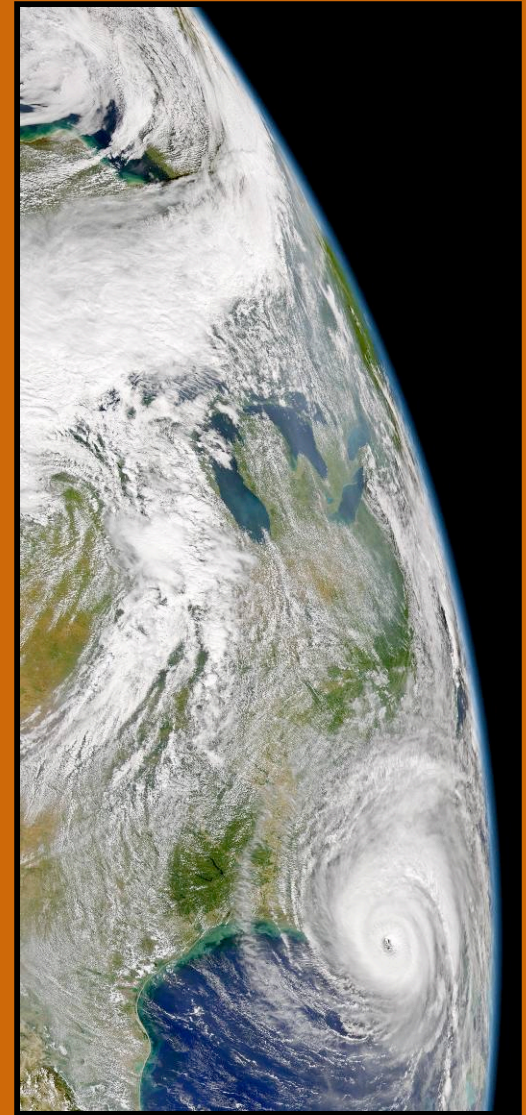
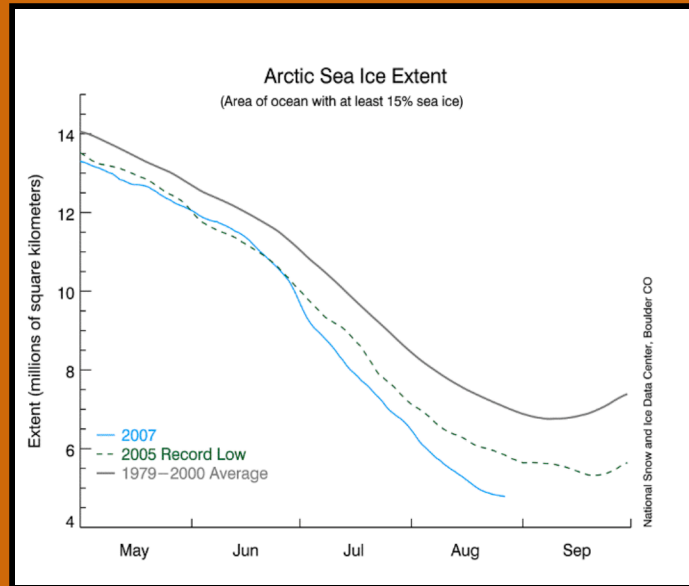
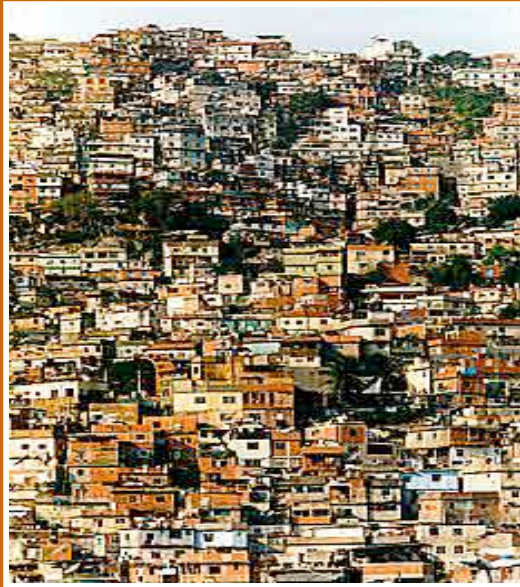
Where are you from?



A Healthy Place



A Troubled Place



6 Adaptive Response Options

- Preventing loss
- Tolerating loss
- Spreading or sharing loss
- Changing use or activity
- Changing location
- Restoration

Carter, et al, 1996

The Importance of Adaptive Capacity

Defining and Enhancing Adaptive Capacity

- **The ability of a system to adjust to climate change**
- **Identifying stakeholders and engaging them**
- **Assess generic adaptive capacity - we all don't start from the same place**
- **Assess social and institutional capabilities**

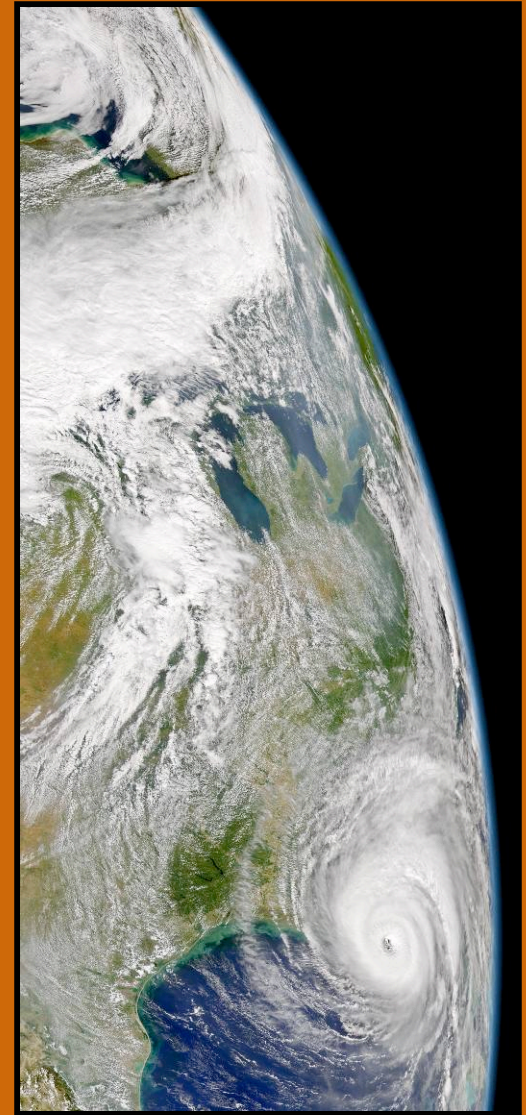
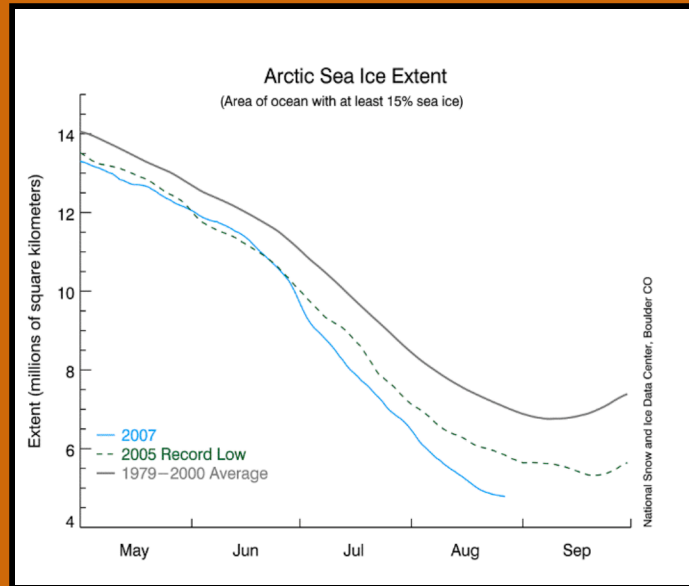
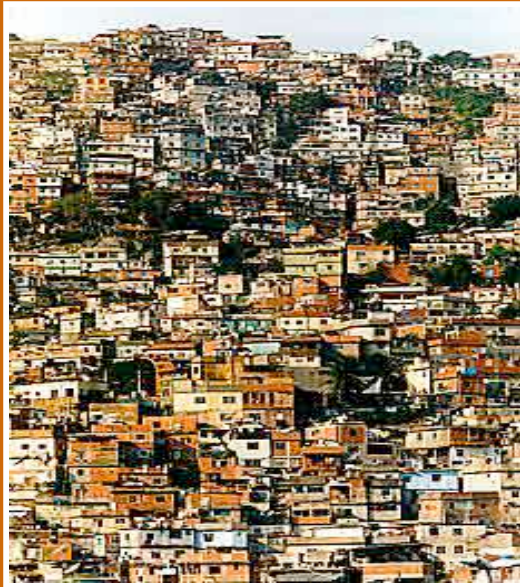
Determinants of Adaptive Capacity

- Consider adaptation as part of a broader sustainable development policy
 - economic resources available
 - access to appropriate technology
 - availability of information and skills
 - infrastructure status and vulnerability
 - institutional stability and legitimacy
 - equitable access to resources

A Healthy Place



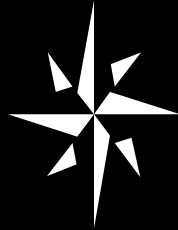
A Troubled Place



Natural
Systems

Human
Systems
private
public

Anticipatory



- Purchase of insurance
- Construction of house on stilts
- Redesign of oil rigs
- Early-warning systems
- New building codes, design standards
- Incentives for relocation

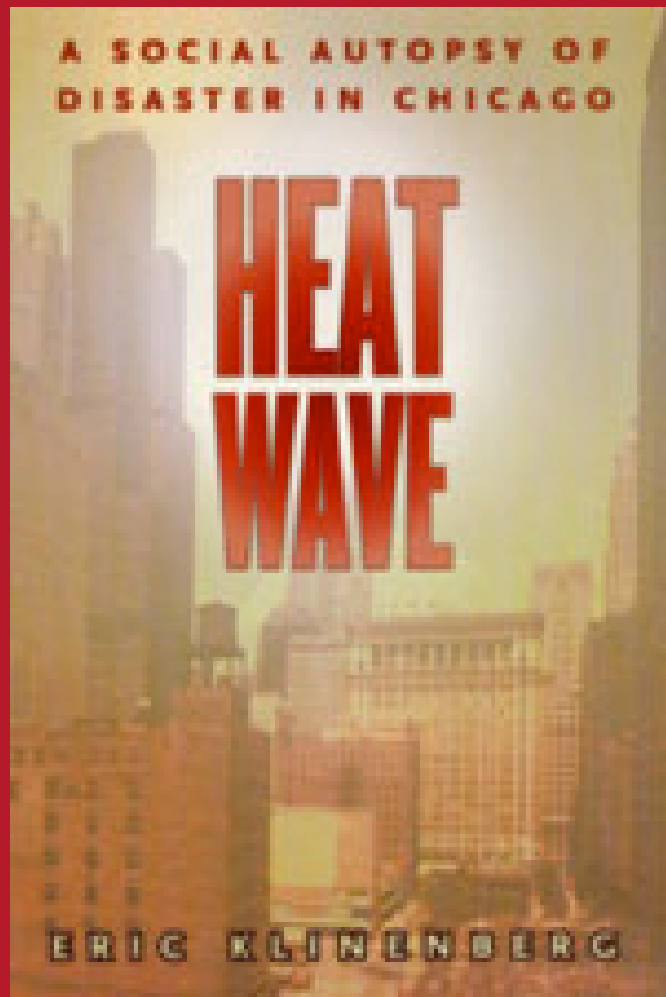
Reactive

- Changes in length of growing season
- Changes in ecosystem composition
- Beach migration
- Changes in farm practices
- Changes in insurance premiums
- Purchase of air-conditioning
- Compensatory payments, subsidies
- Enforcement of building codes
- Beach nourishment

TYPES OF ADAPTATION AND EXAMPLES

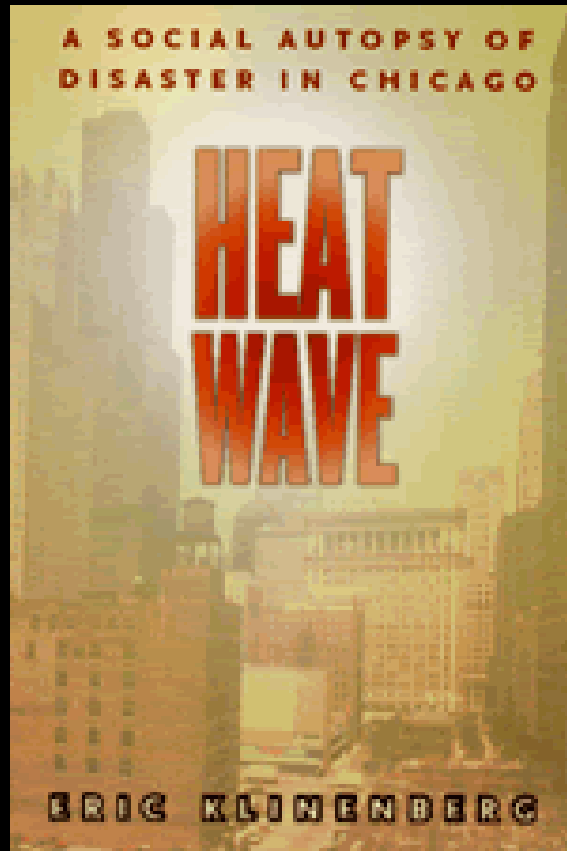
McCarthy et al. 2001

Levels of Adaptation



Adaptation is about more than physical infrastructure - it is also about social, institutional and economic infrastructure

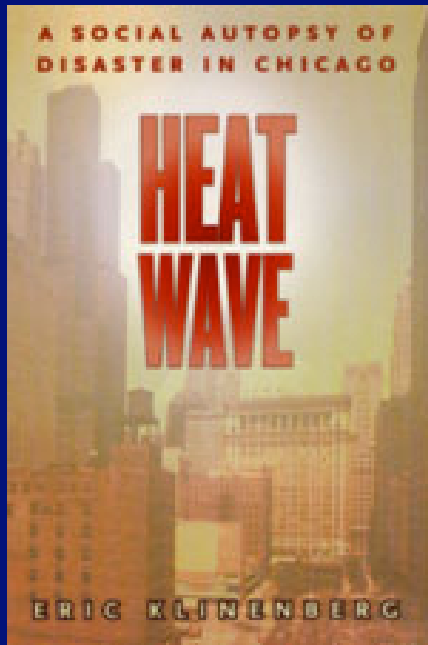
The impacts of climate change - its physical impacts - will likely be amplified by social dysfunction



Climate Change Adaptation in the Face of Heat Wave - What We Learned From the Chicago Heat Wave of 1995

**“Heat Wave is not so much a book about weather,
as about the calamitous consequences of forgetting
our fellow citizens. . . . A provocative, fascinating
book, one that applies to much more than weather
disasters.”**

—Neil Steinberg, Chicago Sun-Times



“Of course forces of nature played a major role. But these deaths were not an act of God. The authors of an article in the American Journal of Public Health said that the most sophisticated climate models "failed to detect relationships between the weather and mortality that would explain what happened in July 1995 in Chicago.” Hundreds of Chicago residents died alone, behind locked doors and sealed windows, out of contact with friends, family, and neighbors, unassisted by public agencies or community groups. There's nothing natural about that.”

Eric Klinenberg

©2002 The University of Chicago

Public Health Role

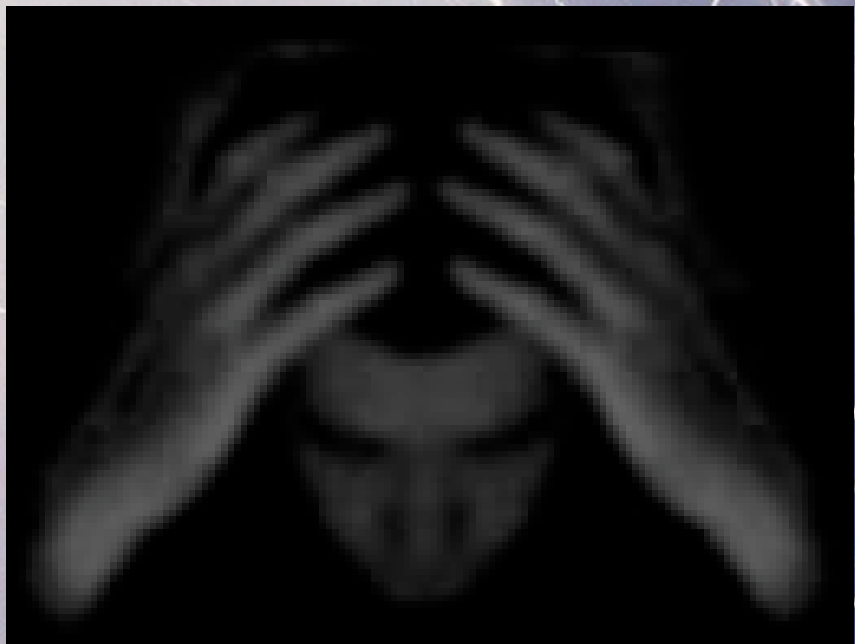
- Despite existing breadth of organizations and sectors with initiatives on climate change
- Despite the anticipated health effects of climate change

The public health effects of climate change remain largely unaddressed

Health Effects of Displacement

- Exacerbation of chronic disease
- Depression
- Suicidality
- Disempowerment
- Disengagement
- Community paralysis



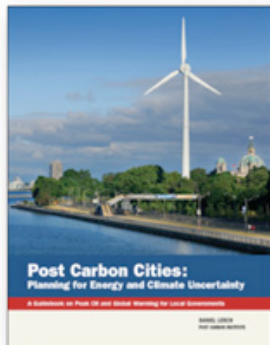


DESPAIR

Who is Already Preparing for Climate Change?



Is your city ready for
peak oil and
global warming?



Post Carbon Cities:
Planning for Energy and
Climate Uncertainty

*A new guidebook for local governments.
Fall 2007. 113 pages, \$30.*

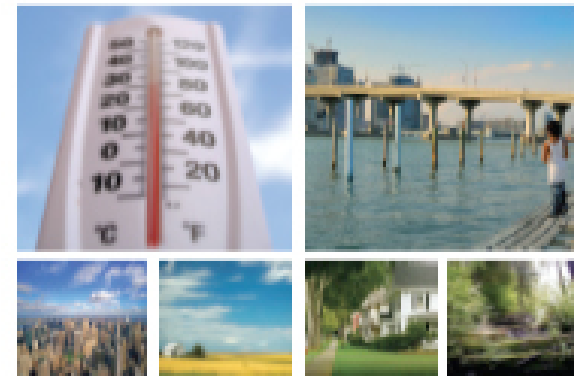
Water Utilities Climate Alliance



World Bank

PREPARING FOR CLIMATE CHANGE

A Guidebook for Local, Regional,
and State governments



Edited by
Cristina del Campo in the Earth System (The Climate Impact Group)
Institute for the Study of the Atmosphere and Ocean
University of Washington
King County, Washington
With an introduction by King County Executive Ron Sims





- **Climate Change is a threat to the national security of the United States**
- **Climate Change will destabilize currently stable societies**
- **Climate Change will further destabilize already unstable societies - becoming a “threat multiplier”**
- **Climate Change is a threat to national security infrastructure world-wide**

Planning for Sea Level Rise - 3 Serious Responses

- **New York City - Columbia University and the NYC Department of Environmental Protection**
- **California Department of Water Resources**
- **United Kingdom**



“Scheduled Adaptation”

- Storm surge barriers
- Sea walls
- Infrastructure hardening
- Infrastructure relocation
- Population relocation

“California panel urges 'immediate action' to protect from rising sea levels”

**55 inch sea level rise
by 2100 - according
to climate models**



San Francisco Bay Scenarios for Sea Level Rise SFO



Map is based on USGS 10000 San 02M and National Wetlands Imagery Program data. Map is illustrative and depicts a potential inundation scenario in 2100. Limitations in the geospatial data available may affect accuracy. Map should not be used for planning purposes.

**This would
give new
meaning to
the words:
“In the event
of a water
landing....”**



Aerial view of the Thames Barrier with all gates up from the bottom of the river to staunch the flow of the water in the river. Source: <http://www.the-river-thames.co.uk/weather.htm>; accessed January 5, 2006.



Aerial view of the Thames Barrier with a ship passing through. Source: http://www.bbc.co.uk/london/content/images/2005/08/25/089_430x308.jpg; accessed January 5, 2006.



The Thames Barrier - Keeping the North Sea out of the London Underground

In the United Kingdom, the response is being called “managed retreat.” Coastal areas are no longer being shored up and property owners are being left to their own resources. Relocation is underway.



Time to Move?





Galveston Ponders the “Ike Dike”

2008 Climate Report for Tucson

**14th warmest and 23rd
driest year on record
10th straight year of above
normal temperatures
8th straight year of below
normal rainfall**

NWS, Tucson



Tucson's Emergent Response

**to Drought and
Climate Change**

**Drought Preparedness and Response Plan
(2003 - 2007)**

**Mayor's Climate Protection Agreement
(2006)**

**Office of Conservation and Sustainable
Development (2006)**



Tucson's Emergent Response to Drought and Climate Change

Framework for Advancing Sustainability (2008)

Regional Greenhouse Gas Inventory (2008)

Rainwater Harvesting Ordinance (2008)

**Climate Change Advisory Committee
(2008-present)**

Joint City-County Water Task Force (2008-present)

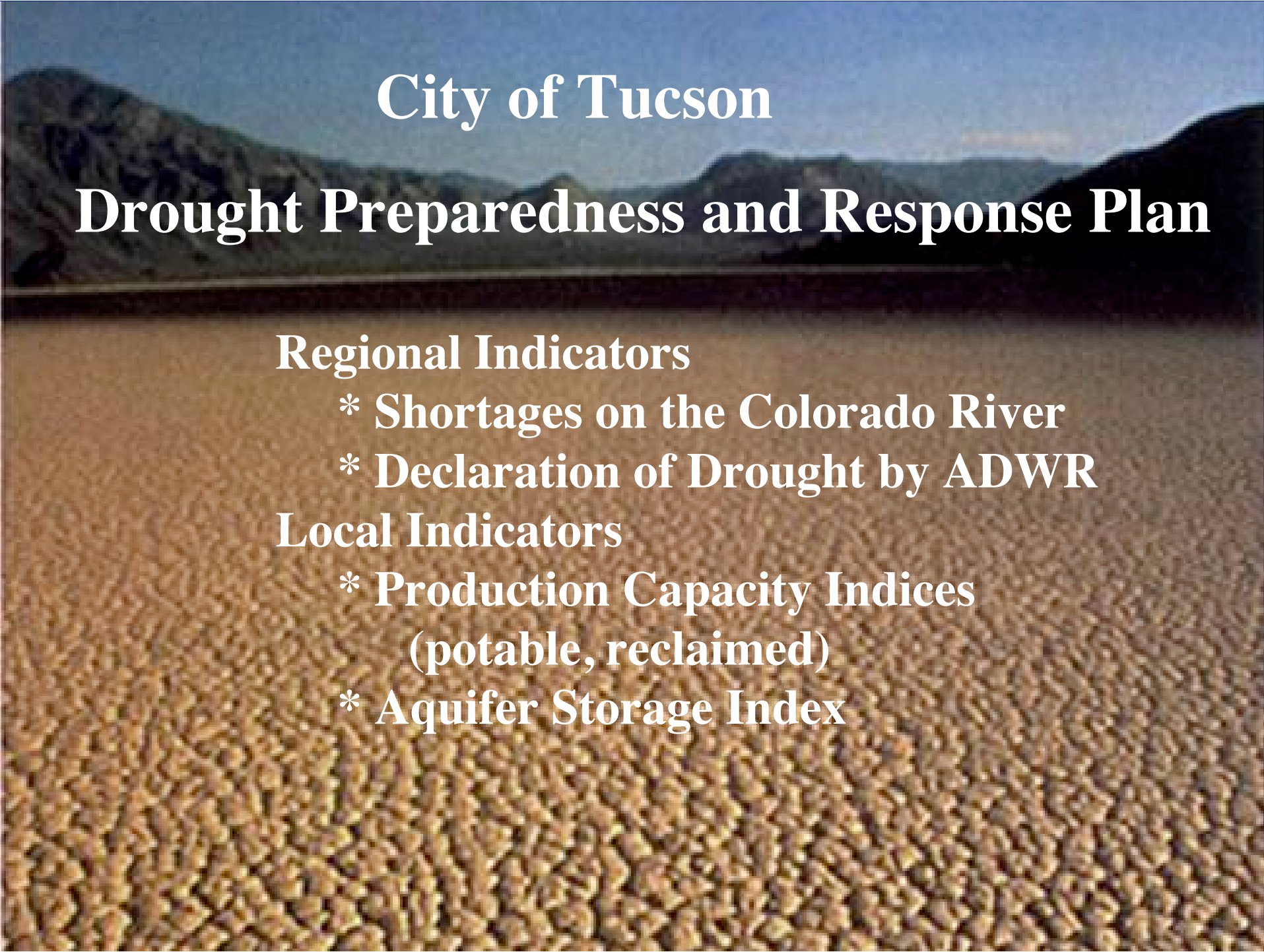
Community Initiatives (ongoing)

City of Tucson

Drought Preparedness and Response Plan

Drought: “sustained natural reduction in precipitation that results in negative impact to the environment and human activities.”

**Arizona Drought
Preparedness Plan**



City of Tucson

Drought Preparedness and Response Plan

Regional Indicators

- * Shortages on the Colorado River
- * Declaration of Drought by ADWR

Local Indicators

- * Production Capacity Indices
(potable, reclaimed)
- * Aquifer Storage Index

Drought Triggers in the Tucson Plan

**Stage 1: Sustained Drought
on the Colorado River**

**Stage 2: Declaration of Shortage
on the Colorado River by
the Secretary of Interior**

**Stage 3: Reduction in CAP
Deliveries**

**Stage 4: Further Reduction in
CAP Deliveries**

City of Tucson Emergency Evacuation Plan

- ‘The City of Tucson maintains the ability to respond to “all hazards” emergency incidents, including but not limited to
 1. Natural
 - * Drought
 - * Rural-Urban Interface Fires
 - * Etc....’

Why Local Government Leadership in Climate Change Adaptation?

- Localities are on the front line of Climate Change; inaction is not an option**
- Adaptation is good governance and good risk management**
- Early actions avoid the high economic and social costs of delayed adaptation**
- Climate Change preparedness is similar to local emergency preparedness but over a much longer time frame**

Why Local Government Leadership in Climate Change Adaptation?

- **Adaptation can secure multiple community benefits (i.e. rapid solar energy deployment) creates local jobs, keeps money locally, and positions communities securely in a regional and global economy**

Climate Change Synergies Mitigation and Adaptation

Heat wave plans, “buddy systems”	Improved social capital/resilience
Reduced vehicular travel	Fewer accidents, reduced air pollution, healthier populace
Fuel efficiency	Reduced air pollution, healthier populace
Locally grown food	Reduced pesticide loading, healthier populace
Energy-efficient buildings	Lower operating costs, economic security
Alternative energy sources	Business opportunities, economic security

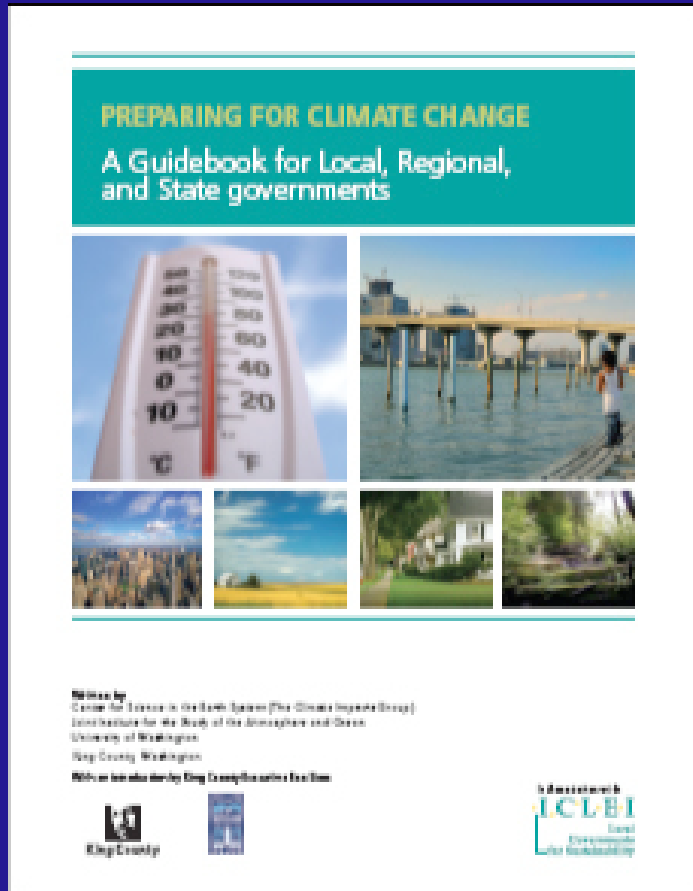
Climate Change Adaptation planning will affect those with responsibilities for:

- **Ensuring safe and reliable public services**
- **Ensuring environmental quality**
- **Economic development**
- **Land use planning and zoning**
- **Fiscal responsibility and risk management**

**: Climate Change Adaptation
planning will affect those with
responsibilities for:**

- Capital investments**
- Emergency response**
- Water resources management**
- Public health**
- Ecosystem management**
- Transportation infrastructure**

A Guidebook for Local, Regional, And State Governments



Building a Climate Preparedness Plan

- 1. Scope Impacts in Your Major Sectors**
- 2. Build Support for Action**
- 3. Establish a Preparedness Team**
- 4. Identify Planning Areas Relevant to CC**
- 5. Conduct a CC Vulnerability Assessment**

Building a Climate Preparedness Plan

- 6. Conduct a Climate Change Risk Assessment**
- 7. Set Preparedness Goals and Develop Your Preparedness Plan**
- 8. Implement the Plan**
- 9. Measure Progress and Update the Plan**
- 10. Share Findings**

**SCOPE THE IMPACTS IN
YOUR MAJOR SECTORS:
(HEALTH, TRANSPORTATION, AGRICULTURE,
UTILITIES, FORESTS, WATER RESOURCES, ETC.)**

**COLLECT
EXISTING
INFORMATION**

**CONSIDER
A RANGE
OF SOURCES**

**UNDERSTAND
UNCERTAINTY
IN THE DATA**

**SIZE OF
CHANGE
COMPARED TO
RECENT
CHANGES**

BUILD AND MAINTAIN SUPPORT TO PREPARE FOR CLIMATE CHANGE

- 1. IDENTIFY A CHAMPION**
- 2. IDENTIFY AND UNDERSTAND
YOUR AUDIENCES**
- 3. DEVELOP A PREPAREDNESS MESSAGE**
- 4. SPREAD THE MESSAGE**
- 5. USE SOCIAL MARKETING AND OTHER
COMMUNICATION TOOLS**

BUILD YOUR CLIMATE CHANGE PREPAREDNESS TEAM

- **WHY A TEAM**
- **SELECTING TEAM MEMBERS**
- **SELECTING A TEAM LEADER**
- **IDENTIFY THE TEAM'S
RESPONSIBILITIES**

IDENTIFY PLANNING AREAS RELEVANT TO CLIMATE CHANGE

- **AREAS FOR WHICH PLANNING
BODY HAS AUTHORITY**
- **AREAS ARE SUBSETS OF BROADER
SECTORS -**

Sector - Transportation

Planning Area - Road Maintenance

- **LINK STRESSORS TO EACH AREA**

CONDUCT A CLIMATE CHANGE VULNERABILITY ASSESSMENT

- 1. REVIEW AND SUPPLEMENT
IMPORTANT CLIMATE INFORMATION**
- 2. CONDUCT A CLIMATE SENSITIVITY
ANALYSIS**
- 3. EVALUATE THE ADAPTIVE CAPACITY
ASSOCIATED WITH SYSTEMS IN YOUR
PLANNING AREA**
- 4. SUM AND ASSESS THE VULNERABILITIES**

CONDUCT A CLIMATE CHANGE RISK ASSESSMENT

$$\text{RISK} = \text{CONSEQUENCE} \\ \times \text{PROBABILITY}$$

A SAMPLE RISK ESTIMATE

PLANNING AREA	CURRENT & EXPECTED STRESSES	PRO- JECTED CC IMPACT	CONSE- QUENCE OF IMPACT (HIGH, MEDIUM, LOW)	PROBABI- LITY OF IMPACT (HIGH, MEDIUM, LOW)	ESTMATED RISK TO SYSTEMS IN THIS PLANNING AREA
WATER SUPPLY	SUMMER DROUGHT	MORE WATER STRESS IN SUM- MERS	HIGH - THREAT TO PUBLIC SAFETY, LOSS OF CONSUMER CONFIDENCE	HIGH - ALREADY A CONCERN AND WARMER, DRIER CON- DITIONS EXPECTED	HIGH

SET PREPAREDNESS GOALS AND DEVELOP PREPAREDNESS PLAN

- **ESTABLISH A VISION AND GUIDING PRINCIPLES**
- **SET PREPAREDNESS GOALS**
- **IDENTIFY POTENTIAL PREPAREDNESS ACTIONS**
- **SELECT AND GIVE PRIORITY TO PREPAREDNESS ACTIONS**

IMPLEMENT THE PLAN

**MEASURE PROGRESS AND UPDATE
- REVIEW ASSUMPTIONS**

SHARE LESSONS LEARNED

Community Responsibility

- Learn the risks
- Support local government action
- Participate in your local adaptation planning process
- Use a climate change filter on all expenditures
- Prepare for worst-case and seek co-benefits of adaptive measures



Mitigation or Adaptation

YES!

Easter Island: They Didn't Make It!





Now we get to decide

How Gutsy Are We?

